

REMARKS:

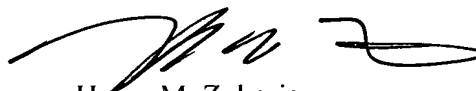
By this Preliminary Amendment, the Title, Abstract, Specification, and Claims have been revised to improve their clarity and so as to meet U.S. patent practice. As evidenced by the marked-up copy of the original Title, Abstract, Specification, and Claims, no new matter has been added.

Entry of this Preliminary Amendment prior to the examination of the application is respectfully requested.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 07-1337 and please credit any excess fees to such deposit account.

Respectfully submitted,

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Claims:What is claimed is:

1. A method of operating a peripheral device enabled to communicate
5 using a SCSI (small ~~Small~~ computer ~~Computer~~ system ~~System~~ interface
Interface) protocol, ~~said the~~ method comprising:

receiving a SCSI command write/read signal;

10 receiving a SCSI inquiry signal; and

delaying initiating a response to the SCSI inquiry signal by the peripheral
device for a predetermined time period in response to receipt of the received
SCSI command write/read signal and the received SCSI inquiry signal.
15 ~~in response to receipt of said received SCSI command write/read signal and said~~
~~received SCSI inquiry signal, causing said peripheral device to delay initiating a~~
~~response to the SCSI inquiry signal for a predetermined time period.~~

2. The method as claimed in claim 1, further comprising:

20 setting a delay timer and entering a delay mode for delaying ~~said the~~
peripheral device initiating a response to said SCSI inquiry signal, ~~said the~~ delay
mode ~~set to extend for said~~ extending for the pre-determined time period.

25 3. The method as claimed in Claim 1, further comprising:

~~upon expiry of said pre-determined time period, responding to said the~~
SCSI command write/read signal by performing an arbitrary host selection
procedure and performing a data transfer procedure after passage of the
30 predetermined time period.

4. A tape data storage device comprising:

a tape drive mechanism ~~for accepting~~ adapted to accept a removable tape data storage media for storage of data;

at least one buffer memory ~~for~~ adapted to temporarily storing store data to be read to said tape data storage media and to be written from said tape data storage media;

a SCSI (small computer system interface Small Computer System Interface) driver; and

a controller device ~~for controlling~~ adapted to control said buffer memory, said tape drive mechanism and said small computer system interface driver;

wherein said tape data storage device ~~operates~~ is adapted to:

receive a SCSI command write/read signal;

receive a SCSI inquiry signal; and

delay initiating a response to the SCSI inquiry signal by said peripheral device for a predetermined time period in response to receipt of said received SCSI command write/read signal and said received SCSI inquiry signal.

~~in response to receipt of said received SCSI command write/read signal and said received SCSI inquiry signal, cause said peripheral device to delay initiating a response to the SCSI inquiry signal for a predetermined time period.~~

5. The tape data storage device as claimed in claim 4, further ~~operating~~ adapted to:

set a ~~timer~~timer and enter a delay mode, ~~said delay mode which which~~
delays said data storage device initiating a response to said SCSI inquiry signal
~~set to extend for a~~ the pre-determined time period.

5 6. The tape data storage device as claimed in claim 4, further ~~operable~~
adapted to:

~~upon expiry of said pre-determined delay time period,~~ respond to said SCSI
command write/read signal by performing an arbitrary host selection procedure
10 and performing a data transfer procedure after passage of the predetermined
time period.

7. A driver for operating a SCSI (small computer system interface
Small Computer System Interface) enabled peripheral device enabled to
15 communicate with at least one other SCSI enabled device according to the SCSI
protocol, said driver comprising:

~~means for receiving~~ At least one received or adapted to receive a SCSI
command write/read signal; and a SCSI inquiry signal; and
20

~~means for receiving a SCSI inquiry signal; and~~

a delay timer to measure a predetermined time period;

25 wherein said driver is adapted to cause said peripheral device to delay
initiating a response to the SCSI inquiry signal for said measured predetermined
time period in response to receipt of said received SCSI command write/read
signal and said received SCSI inquiry signal. ~~wherein in response to receipt of~~
~~said received SCSI command write/read signal and said received SCSI inquiry~~
30 ~~signal, said driver causes said peripheral device to delay initiating a response to~~
~~the SCSI inquiry signal for a predetermined time period.~~

8. The driver as claimed in claim 7, wherein said driver ~~operates~~ is adapted to set a delay timer and enter a delay mode, said delay mode set to extend extending for said pre-determined time period.

9. The driver as claimed in Claim 7, wherein ~~when in said delay mode, said driver delays~~ is adapted to delay sending a response to said SCSI inquiry signal when in said delay mode.

10. The driver as claimed in Claim 7 ~~which operates such that, wherein upon expiry of said pre-determined delay time period, said driver responds~~ is adapted to respond to said SCSI command write/read signal by performing an arbitrary host selection procedure and performing a data transfer procedure upon passage of the predetermined time period.

11. A system of computer entities, ~~communicating~~ arranged to communicate via a SCSI (small computer system interface Small Computer System Interface), said system comprising:

at least one host computer entity; and

at least one target computer entity;

said system ~~operating such that~~ is adapted to:

initiate arbitration by the target entity;

select the host computer; and

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to commence data transfer between the host computer and target entity during a bus free period comprising the inquiry period of an inquiry initiated by said host computer to said target entity, arbitration is initiated by the target entity, to select the host computer and commencement of data transfer between the host computer and target entity can occur during a bus free period comprising the inquiry period of an inquiry initiated by said host computer to said target entity.

12. ~~Program data comprising program instructions for causing a processor to operate a small computer system interface (SCSI) protocol driver, said driver operating to:~~ A program storage device, readable by a machine, tangibly embody a method of causing a processor to operate a SCSI (Small Computer System Interface) protocol driver, the method comprising:

~~receive~~ receiving a SCSI command write/read signal;

~~receive~~ receiving an SCSI enquiry signal;

setting a delay timer to measure passage of a predetermined time period in response to receipt of said received SCSI command write/read signal and said received SCSI inquiry signal; and

responding to said SCSI inquiry in response to the measured predetermined time period having passed in response to receipt of said received SCSI command write/read signal and said received SCSI inquiry signal, set a delay timer to extend for a pre-determined time period; and

~~on expiry of said time period, respond to said SCSI enquiry.~~

13. A driver for operating a SCSI (small computer system interface Small Computer System Interface) enabled peripheral device enabled to

communicate with at least one other SCSI enabled device according to the SCSI protocol, said driver operable to: comprising:

5 | ~~receive a receiver adapted to receive a~~ SCSI command write/read signal;
| and to
| receive a SCSI inquiry signal; and

10 | a delay timer adapted to measure a predetermined time period;

15 | wherein said driver is adapted to cause said peripheral device to delay
| initiating a response to said SCSI inquiry signal for said measured predetermined
| time period in response to receipt of said received SCSI command write/read
| signal and said received SCSI inquiry signal.~~wherein in response to receipt of~~
| ~~said received SCSI command write/read signal and said received SCSI inquiry~~
| ~~signal, said driver operates to cause said peripheral device to delay initiating a~~
| ~~response to said SCSI inquiry signal for a predetermined time period.~~



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MARKED UP VERSION SHOWING CHANGES MADE (OFFICIAL)

-1-

Title

**SCSI--HANDLING OF I/O SCANS TO MULTIPLE LUNs DURING
WRITE/READ COMMAND DISCONNECTS**

Background of the Invention

Field of the Invention

The present invention relates to the field of computers and particularly, although not exclusively to a small computer system interface (SCSI) connection between two or more computer entities.

~~Background of the Invention~~ Description of the Related Art

The small computer system interface (SCSI) is well known to those in the art of computer science and comprises a protocol for allowing communication between a plurality of computer entities, for example a host computer and one or more peripheral devices. There are many types of host computer device known in the art and also many types of peripheral devices known in the art which art that can communicate with each other via the known SCSI interface.

The specification for SCSI can be obtained from American National Standards Institute, 1430 Broadway, New York 10018. The SCSI specification (ANSI Standard X3.131-1986) defines a high performance peripheral interface which interface that distributes data among peripherals independently of a host computer, thereby freeing a host computer for more user oriented activities.

Referring to Fig. 1 herein, there is illustrated schematically depicts a typical SCSI arrangement in which a host computer 100 is connected via a SCSI bus to a plurality of tape drive data storage devices 101 – 103.

Referring to Fig. 2 herein, there is illustrated schematically is a logical diagram of the arrangement of Fig. 1. Host computer 200 communicates with a plurality of tape drive data storage back-up devices 201 – 203 via a SCSI bus 204.

Each device has a SCSI driver. Host computer 200 has a host driver, whereas each peripheral device 201 – 203 has a peripheral device SCSI driver.

In the particular example of a Hewlett Packard UX type host device, communicating with a tape drive data storage back-up peripheral, via a SCSI interface, there has been experienced the particular problem that hangs/disconnects of the SCSI interface may can occur, even when the behavior of two or more tape drive units 201 – 203 and the host computer is perfectly legal, i.e. that is, within the SCSI specification.

In the context of data back-up, having hangs/disconnects of a SCSI interface bus between a host computer and a peripheral back-up/backup data storage device can cause failure of back-up/backup of data and is therefore to be avoided if possible.

Specific implementations according to the present invention have arisen from the need to identify the cause of the hangs/disconnects on the SCSI interface and to implement a solution to those hangs/disconnects.

Summary of the Invention

Where a SCSI peripheral device is writing or reading after an SCSI command phase originating from a SCSI host computer device, the peripheral device maycan disconnect from the SCSI bus. The SCSI bus is then deemed free for the host computer to issue further SCSI inquiry commands to peripherals on the bus, to determine which peripheral devices are connected to the bus. This I/O scan process takes a relatively long period of time, relative to the SCSI command phase, bus free period and response from the peripheral device to the SCSI command phase.

10 | ~~In a best mode implementation~~ one embodiment in accordance with ~~of the present invention~~, a peripheral device allows a relatively long period of time for the I/O scan process to interrogate each peripheral device on the bus. The time out delay allowed by the peripheral is long enough for the host computer to determine which devices are connected on the SCSI bus.

15 | ~~In one embodiment in accordance with the present invention~~ According to a best mode implementation, ~~there is provided a method of operating a SCSI enabled computer peripheral device~~ is provided wherein the peripheral device waits a period of time if it detects that an I/O scan has been issued after a write/read command has disconnected.

20 | This maycan have the advantage of avoiding a prior art problem wherein a peripheral device is legally allowed within the SCSI protocol to re-select a host computer during and I/O scan period, that is, i.e. when the bus is free, and to continue with a read/write data phase. In some prior art operating systems and SCSI drivers, to continue a write/read data phase during an I/O scan period causes prior art systems to crash. Specific implementations according to the present invention maycan have an advantage of avoiding such crashes.

25 | ~~According to a first aspect of the present invention, there is provided a method~~ a method of operating a peripheral device enabled to communicate using

a SCSI (small-~~Small~~ computer-~~Computer~~ system-~~System~~ interface-~~Interface~~)
protocol is provided, ~~said the~~ method comprising:

receiving a SCSI command write/read signal;

receiving a SCSI inquiry signal; and

~~in response to receipt of said received SCSI command write/read signal and~~
~~said received SCSI inquiry signal, causing said peripheral device to delaying~~
initiating a response to the SCSI inquiry signal by the peripheral device for a
predetermined time period in response to receipt of the received SCSI command
write/read signal and the received SCSI inquiry signal.

According to ~~ato~~ a second aspect of the present invention there ~~is provided~~
a tape data storage device is provided, the device comprising:

a tape drive mechanism ~~for accepting~~ adapted to accept a removable tape
data storage media for storage of data;

at least one buffer memory adapted to ~~for~~ temporarily storing data to be
read to said tape data storage media and to be written from said tape data
storage media;

a SCSI (small-~~Small~~ cComputer system-~~interface~~System Interface) driver;
and

a controller device adapted to ~~for~~ controlling said buffer memory, said tape
drive mechanism and said ~~small computer system interface~~ SCSI driver;

wherein said tape data storage device ~~operates~~ is adapted to:

receive a SCSI command write/read signal;

receive a SCSI inquiry signal; and

5 ~~in response to receipt of said received SCSI command write/read signal and~~
~~said received SCSI inquiry signal, cause said peripheral device to delay initiating~~
a response to the SCSI inquiry signal signal by said peripheral device for a
predetermined time period in response to receipt of said received SCSI
command write/read signal and said received SCSI inquiry signal.

10

15 According to a third aspect of the present invention, ~~there is provided a~~
~~driver a driver~~ for operating a SCSI (small Small computer Computer system
System interface Interface) enabled peripheral device enabled to communicate
with at least one other SCSI enabled device according to the SCSI protocol is
provided, said driver comprising:

20

~~means at least one receiver for adapted to receiving receive a SCSI~~
command write/read signal and; a SCSI inquiry signal; and

~~means for receiving a SCSI inquiry signal; and~~

25

a delay timer to measure a predetermined time period;

30

~~wherein in response to receipt of said received SCSI command write/read~~
~~signal and said received SCSI inquiry signal, said driver causes is adapted to~~
cause said peripheral device to delay initiating a response to the SCSI inquiry
signal for a said measured predetermined time period in response to receipt of
said received SCSI command write/read signal and said received SCSI inquiry
signal.

According to a fourth aspect of the present invention, ~~there is provided a~~
~~systema system~~ of computer entities, ~~adapted to communicating communicate~~
via a SCSI (small Small computer Computer system System interfaceInterface) is
5 provided, said system comprising:

at least one host computer entity; and

at least one target computer entity;

10

wherein said system is adapted to operative to:

initiateg such that:

15

~~arbitration is initiated by the target entity, to;~~

select the host computer; and

20

to commencement of data transfer between the host computer and target
entity ~~can occur during a bus free period comprising the inquiry period of an~~
inquiry initiated by said host computer to said target entity.

25

According to a fifth aspect of the present invention, ~~there is provided a~~
~~program data comprising~~ storage device, readable by a machine, tangibly
embodying a method of program instructions for causing a processor to operate a
SCSI (small computer system interface Small Computer System Interface)
(SCSI) protocol driver is provided, said driver operating to: the method
comprising:

30

~~receive~~ receiving a SCSI command write/read signal;

receive ~~receiving~~ an SCSI inquiry signal;

in response to receipt of said received SCSI command write/read signal and
said received SCSI inquiry signal, set ~~setting~~ a delay timer to extend for measure
5 a passage of a pre-determined time period in response to receipt of said received
SCSI command write/read signal and said received SCSI inquiry signal; and

on expiry of said time period, responding to said SCSI inquiry in response to
10 the measured predetermined time period having passed.

The invention includes a driver for operating a SCSI (small-Small computer
Computer system-System interface-Interface) enabled peripheral device enabled
to communicate with at least one other SCSI enabled device according to the
SCSI protocol, said driver operable comprising to:

15 a receiver adapted to receive a SCSI command write/read signal and to
receive a SCSI inquiry signal; and;

20 receive a SCSI inquiry signal; and

a delay timer adapted to measure a predetermined time period;

25 wherein in response to receipt of said received SCSI command write/read
signal and said received SCSI inquiry signal, said driver-operates- is adapted to
cause said peripheral device to delay initiating a response to said SCSI inquiry
signal for a said measured predetermined time period in response to receipt of
said received SCSI command write/read signal and said received SCSI inquiry
signal.

30 Other aspects of the invention are as recited in the claims herein.

Brief Description of the Drawings

For a better understanding of the present invention and to show how the same ~~may~~can be carried into effect, there will now be described by way of
5 example only, specific embodiments, methods and processes according to the present invention with reference to the accompanying drawings in which:

Fig. 1 ~~illustrates schematically~~ depicts the general arrangement of a host computer connected to a peripheral tape data storage device via a SCSI bus as
10 is known in the prior art;

Fig. 2 depicts ~~illustrates schematically~~ a logical view of the arrangement of Fig. 1 ~~illustrating~~ including a host computer device and a plurality of peripheral computer devices connected to a SCSI bus as is known in the prior art;

15 Fig. 3 depicts ~~illustrates schematically~~ a sequence of messages according to the SCSI protocol between a SCSI host computer and at least one SCSI peripheral device;

20 Fig. 4 depicts ~~illustrates schematically~~ a second message sequence initiated by a host device for sending an inquiry command to a peripheral device;

Fig. 5 depicts ~~illustrates schematically~~ components of a tape data storage device, having a SCSI interface and controller according to a specific
25 implementation of the present invention;

Fig. 6 depicts ~~illustrates schematically~~ a state diagram and process steps operated by the tape data storage device in Fig. 5 for implementing a specific process according to the present invention; and
30

Figs. 7 - 9 ~~illustrates~~ depict schematically states and processes according to the specific implementation of the present invention, operated by a tape data storage device for avoiding a ~~hang~~ disconnect of an SCSI interface of the tape data storage device.

5

Detailed Description of the Best Mode for Carrying Out the Invention

There ~~will now be described by way of example the best mode contemplated by the inventors for carrying out the invention.~~ In the following description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be apparent however, to one skilled in the art, that the present invention ~~may~~can be practiced without limitation to these specific details. In other instances, well known methods and structures have not been described in detail so as not to unnecessarily obscure the present invention.

15

In the following description, a problem with the prior art host computer and host SCSI driver and prior art peripheral device and peripheral driver in a tape data storage ~~back-up~~backup device of Figs 1 and 2 is described.

20

~~Referring to Fig. 3 herein, depicts there is illustrated schematically a~~ sequence of messages according to the SCSI protocol, between an SCSI host computer 201 and a plurality of SCSI peripheral devices 201 – 203 attached to the SCSI bus. A host driver at the host computer sends inquiry commands to each driver connected to the bus. Each driver connected to the bus has its own unique identification number (LUN) ~~which~~ that in this case, are number 0 to 15. An I/O scan process sends inquiry commands to each peripheral device in turn. Some drivers may not exist on the LUN addresses. However, for those ~~drivers~~ which drivers that do exist, the drivers of those peripheral devices send back data identifying the type of peripheral device in each case.

30

In the case of a host computer communicating with one or more peripheral tape data storage devices (tape drives), the I/O process can occur at any point in time and therefore could clash with a period when the host computer is performing a data back-up operation to one or more of the tape data storage peripheral devices, or could clash with a period when the host computer is restoring data from one of the tape data storage peripheral devices. Therefore, when inquiry commands are being issued, they ~~may~~can be inter-leaved on the SCSI bus with read commands from the peripheral devices to the host or from the host to a tape data storage device.

A bus free interval 300 occurs when there are no transactions on the bus. After the bus free interval, there occurs an arbitration host selection period 301, where the host computer communicates on the bus, in order to select a particular peripheral device. The arbitration process according to the SCSI protocol, protocol is a process whereby a single device can seize control of the bus and select another device connected to the bus, with which to communicate. Once a peripheral device is selected, there follows a command phase 302, where ~~either a write command or a read command is issued by the host computer~~the host computer issues either a write command or a read command.

The selected peripheral device, in response to the command write/read, needs to set up internal buffers and prepare data to be communicated with the host. There occurs a disconnect of the peripheral device from the bus, ~~whilst~~ while the selected drive prepares itself to communicate with the host computer. Hence, a second bus free period 303 occurs. After the second bus free period, which ~~can have~~ be an arbitrary time period, the peripheral device seizes the SCSI bus and selects the host computer in the second arbitrary host selection period 304. This is followed by a data transfer period 305, in which data is transferred between the host computer and the peripheral device. In the case of a write command, data is transferred from the host computer to the peripheral

device. In the case of a read command, data is read from the peripheral tape data storage device back to the host computer.

5 Following the data transfer, there is a command complete phase 306, following which the SCSI bus is released by the tape drive and the SCSI bus enters a third bus free period 307.

10 ~~Referring to Fig. 4 herein, there is illustrated schematically~~ depicts a sequence of SCSI signals which can occur causing a problem in the prior art SCSI enabled peripheral tape data storage device in crashing or ~~hanging~~ disconnecting the SCSI bus.

15 During the second bus free period 303 after the command read/write period 302, before the tape drive is ready to communicate again with the host computer, a problem occurs in that it is possible that the host computer seizes the bus, enters a second host initiated arbitration process 400 for selecting a drive, selects the same drive as previously selected and issues an inquiry command 401. According to the SCSI protocol, following an inquiry command, there is never a disconnect but always a data transfer 402 where data is immediately sent back
20 from the peripheral device to the host.

25 There ~~may~~can be multiple inquiry commands made by the host computer to the same peripheral device. Part of the inquiry command 401 comprises a particular page code embedded within the inquiry command. Therefore, there ~~may~~can be multiple enquiry commands 403 – 405 going back to the host computer with bus free periods ~~406~~periods 406 – 408 between each of these inquiry commands.

30 ~~What has been~~ It has been observed is that, because the inquiry period ~~may~~can occupy a relatively long time period relative to the time period T1 ~~shown in~~ of Fig. 3, in which the tape drive unit arbitrates on the SCSI bus to select the

host and then transfers data between the host computer and the tape drive, ~~that~~
the arbitration process 304 and data transfer process 305 ~~may need to~~ can occur
during the inquiry period 401, without waiting for the end of the inquiry period 401.

5 Typically the whole input/output process will be over in a matter of
milliseconds. This is a relatively long time compared to the second bus free
period 303, in which the host computer waits for the tape drive unit to arbitrate
back for selection of the host computer in second arbitration host selection period
304. Therefore, there is a conflict between the selected tape drive wishing to
10 arbitrate back to the host computer and the host computer initiating a new
arbitration to select the same tape drive. Practically, this means ~~that under that~~
under these conditions, the selected tape drive cannot arbitrate back to the host
computer because it is blocked by the host computer having issued an inquiry to
the selected tape drive, which can cause a crash in the tape drive.

15 One solution would be to replace the host driver, with a new driver
~~which driver that~~ does not arbitrate to a peripheral, immediately after an arbitration
host selection process and command write/read phase. However, in practice
there are a large number of legacy host drivers in existence and replacing all
20 these host drivers with modified host drivers is not practical. Therefore, a
modification of the peripheral device is preferred.

25 ~~The inventors have realized that a~~ A solution to these problems ~~may~~ is to
utilize the bus free periods within the inquiry period 401. During these bus free
periods, it is legal within the SCSI specification, ~~for the tape drive unit to arbitrate~~
back to select the host computer, in order to respond to the original command
write/read 302. Therefore, arbitration initiated by the peripheral tape drive, to
select the host computer, and commencement of data transfer between the host
30 computer ~~and the~~ and the tape drive can occur during a bus free period
comprising the inquiry period 401 of an inquiry initiated by ~~the host~~ the host

computer to the tape drive, where the inquiry occurs after the host computer has issued a command write/read to the tape drive but before the tape drive has had sufficient time to respond to the command write/read.

5 ~~Referring to Fig. 5 herein there is illustrated schematically depicts~~
components of a tape data storage device according to ~~a best~~ an embodiment
~~mode implementation of the present invention.~~ The tape data storage device 500
comprises a SCSI interface 501 capable of communicating with a SCSI bus 502;
at least one data processor 503; a buffer memory 504; a tape drive mechanism
10 505 having a port for accepting a removable tape data storage medium 506; a
controller 507 for controlling input of data through the SCSI interface 501 and for
controlling and managing data storage in the buffer memory 504 and for
controlling data storage and management in the tape drive mechanism 505. The
tape data storage device also comprises power supply, liquid crystal display for
15 showing an operational status of the data storage device as is known in the prior
art.

20 Within the controller 507 is a flash ~~EEPROM which store an algorithm in the~~
~~form of stored program data for operating the tape~~ EEPROM that store an
algorithm in the form of stored program data for operating the tape drive
mechanism, buffer memory, processor 503 and SCSI interface 501. Controller
507 contains program data written in ~~the~~ a conventional program language, for
example, C, or C++, ~~as~~ as is known to those skilled in the art. The program data
comprises ~~an algorithm for causing~~ causes the SCSI enabled peripheral device
25 to operate ~~in modes of operation~~ as follows.

There will now be described operation of a tape data storage device for
overcoming the problem of ~~hangs~~ disconnects caused under conditions in which a
host computer device seizes a SCSI bus during a bus free period after an
30 arbitration host selection period and command write/read period.

In the best mode implementation, a peripheral SCSI driver operates to detect conditions wherein a command from a host driver is outstanding and that an I/O scan is in progress and to delay data transfer either in or out to the host for the overlapped command. The I/O scan has a maximum time period which period
5 that it can take, and therefore, the peripheral driver ~~according to the best mode implementation~~ waits until that I/O scan has finished and then ~~to~~ continues with the data transfer from the write/read command.

Referring to Figs 6 – 9 herein, ~~there is illustrated schematically an algorithm~~
10 ~~for operation~~ are flowcharts depicting the operation of a SCSI driver of a peripheral device. In Figs. 6 – 9, ellipses represent states of the peripheral SCSI driver; indented boxes represent inputs to those states; and quadrilateral boxes represent process steps carried out by the peripheral SCSI driver.

Referring to Fig. 6 herein, in an initial state 600 which can be any state of the SCSI driver, the driver awaits input of an inquiry command 601 from a host computer. On receiving an input inquiry command 601, the peripheral driver determines in process 602, whether a write I/O operation is outstanding and/or whether a read I/O operation is outstanding. If there is no I/O operation
20 outstanding, then in process 603 the peripheral driver resumes the inquiry command and returns to the initial state 604 which the driver was in before the inquiry command 601 was detected.

However, if the peripheral driver is in a particular state 600 and receives an
25 inquiry command 601 from a host computer and in process 602 it is determined that a write I/O is outstanding, then in process 604, a delay flag is set, activating a delay timer. The peripheral driver then proceeds in process 603 to carry out the inquiry command. The inquiry command is always executed irrespective of
30 whether or not there is a write I/O operation outstanding ~~or not~~, or whether or not there is a read I/O operation outstanding ~~or not~~. However, if an I/O operation is

outstanding, the execution of the inquiry command by the peripheral is delayed until the data transfer between the host and the peripheral is completed.

Referring to Fig. 7 herein, if the peripheral driver is in an idle state 700, and
5 is asked to perform a write command, by receiving write command 701 from a
host computer, then in process 702 the tape data storage device needs to secure
a predetermined quantity of buffer space, that is, to reserve a predetermined
amount of data storage capacity in buffer memory 504 of the tape data storage
device in process 702. This reserve memory capacity is required to store data
10 ~~which data that~~ will be sent from the host device to the peripheral device. Once a
write command is received from the host, the peripheral device sets a read/write
input/output flag. In process 703, there is set a flag indicating that a write I/O
operation or read I/O is in progress which is followed by the peripheral driver
entering a buffer space allocation state 704. At this stage, the driver transfers
15 into a further state 704, waiting for buffer memory space to be allocated.

Once buffer memory space is allocated, then a buffer space available signal
is generated. When buffer space is available, then ~~the algorithm determines the~~
20 ~~status of the delay flag is determined.~~ If the delay flag indicates that the
peripheral SCSI interface should not delay any operations, then a direct memory
access (DMA) data transfer from the host to the peripheral tape data storage
device occurs, writing data from a host buffer memory to the peripheral buffer
memory 504 in process 803. The peripheral then reverts to idle state 804. If in
process 802, when the delay flag is checked, a delay timer is set in process 805,
25 this causes the peripheral driver to enter a timer state 806.

Referring to Fig. 9 herein, when timer state 900 expires, resulting in a delay
timer off signal 901, the peripheral driver reverts to a direct memory access
operation 902 resulting in a data transfer and then the peripheral device reverts to
30 an idle state.

It will be appreciated by those skilled in the art, that the peripheral driver as described herein above can be provided as a computer program data download which is input into a prior art tape data storage device having a SCSI interface, as a modification or upgrade to that tape data storage device.

5

Alternatively, the program data implementing the above process maycan be stored on a data storage carrier, for example, a CD-ROM or floppy disk, or maycan be downloaded to a tape data storage device as program data from a host computer. The host computer maycan obtain the peripheral driver electronically, for example, over the ~~internet~~Internet, as an electronic download of data, or maycan acquire the program data for creating the peripheral driver by reading a CD-ROM or other program data storage carrier.

10

Abstract

5 ~~There is disclosed a~~ method ~~of and apparatus handles~~handling of I/O
 peripheral devices on a small computer system interface, ~~wherein a~~ A peripheral
 device, upon receiving an inquiry command, checks whether a write/read I/O
 command is outstanding, and if a write/read I/O command is outstanding, sets a
10 delay flag to ~~delaying said the~~ peripheral device for a predetermined period of
 time; ~~on~~ Upon the expiration of the expiry of said delay time, ~~the peripheral~~
 device initiates a data transfer with ~~the a~~ host device.